

FIELD DATA COLLECTION PROTOCOL FOR THE RIPRAPPED BANKS G.I.S., SACRAMENTO RIVER BANK PROTECTION PROJECT

Introduction and Background

The U. S. Army Corps of Engineers' (Corps') Sacramento River Bank Protection Project (SRBPP) was authorized in 1960 to protect the existing levees and flood control facilities of the Sacramento River Flood Control System. Construction of the SRBPP has continued from 1963 until now, via a series of individual contracts, each involving from a few hundred to several thousand linear feet of bank protection using riprap. The SRBPP action area extends along the mainstem Sacramento River from River Mile (RM) 0 near Collinsville (in the Sacramento-San Joaquin Delta) upstream to RM 194 near Chico Landing; it also includes several distributary sloughs in the Delta and the downstream reaches of major tributaries.

Beginning in the early 1990s, several native fish, which either reside in or pass through waters in the SRBPP action area, have become listed as either threatened or endangered under the Federal Endangered Species Act (ESA). As a result, the Corps has been consulting with the Fish and Wildlife Service (Service) and National Marine Fisheries Service (NMFS), as required under section 7 of ESA, to determine effects of ongoing SRBPP construction contracts to these listed species and to ensure that such construction does not jeopardize any listed species' survival and recovery.

In the late 1990s, both the Service and NMFS determined that existing knowledge and information about previously-placed riprap bank protection on the Sacramento River system, including that placed during 4 decades of SRBPP work, was insufficient for properly analyzing effects (to listed species) of currently-proposed SRBPP action. Both the Service and NMFS requested that the Corps develop and provide for future section 7 consultations, detailed maps showing the location of all riprap along the waterways of the SRBPP action area.

In early 2002, an interagency working group (IWG) composed of representatives from the Corps, State Reclamation Board (the local sponsor for SRBPP), Department of Water Resources (DWR), Service, NMFS and California Department of Fish and Game (CDFG) developed protocols for collecting the riprap data. Furthermore, it was agreed that the Corps would develop this data into a GIS (Geographic Information System) that could be accessed and used by each agency and perhaps eventually by outside entities and the public. The Corps subsequently funded the Service and the Corps' GIS section in Sacramento, California to undertake the field data collection effort and GIS-system development. Field data collection was undertaken and completed during July-October 2002.

This report describes in detail the field data collection protocols. Users of the GIS should be aware of and understand these protocols before attempting any analyses and interpretations using the riprap GIS. The office procedures used by the Corps in creating the GIS from the field data are described elsewhere.

Field Data Collection

Field data were collected by three people working together as a team from a jet-powered boat. The Service provided the boat and a lead biologist/certified boat operator who participated in all of the field surveys. The Corps provided two biologists (both also on internships at the Service), each of whom participated in about half of the field surveys, and a technician who operated the electronic equipment during all surveys.

River banks (i.e., both left and right [downstream aspect] banks) within the SRBPP action area, including along the mainstem Sacramento River, its distributary sloughs, and its major tributaries, were surveyed and mapped. The primary mapping element was the location and characteristics of any riprap (along levees and banks) which was in contact (or nearly so) with the water during mean summer water level (MSL) conditions. When such riprap was present, its linear extent and other relevant attributes were recorded; when riprap was not present, the linear extent and relevant attributes of the earthen (natural) substrates along the MSL shoreline were evaluated and recorded.

Survey data were recorded as “points” and “lines” along the banks, using a GPS unit interfaced with a palm-sized, hand-held computer (*see* the Corps’ description of office procedures for unit specifications). The GPS antenna was positioned on an open deck area near the rear of the boat, which was 21 feet in length. The hand-held computer contained maps of the river(s), derived from USGS 7.5-minute topographic quadrangle sheets and/or recent aerial photographs.

Survey of each riprapped or natural bank section (hereafter, “bank lines” or “lines”) along each riverine channel began with a determination of whether the start of the line was riprapped or composed of natural, earthen substrates. At the starting point of the line, the bow of the boat was nosed briefly (long enough for an accurate GPS “fix” to be acquired) onto the shoreline and the GPS position was recorded. The boat was then motored along the bank line, at a fixed speed (depending on bank and river conditions) and distance from the shoreline, to the line’s end (i.e., where that particular riprap type ended or where the natural bank line changed to a riprapped line). At the line’s end, another GPS point was recorded while the bow of the boat was resting against the shoreline. The end of a line was always governed by a change from riprap to natural bank, or vice versa, or a change in the type of riprap that was present.

For each riprapped line, the attributes of the riprap were evaluated and recorded for the overall line (i.e., all linear feet along the riprapped levee or bank). Attributes, including vegetation and instream characteristics, of natural bank lines, were similarly evaluated and recorded over their entire length. In addition, while the boat was traveling along each line, various other points of interest, including traces of riprap, scour holes, groins, wing dams, boat docks, boat-launching ramps, marinas, vertical banks, and vegetation replanting sites, were recorded (as GPS points) when they were encountered. Whenever any individual attribute or rating value was controversial or otherwise involved some element of subjective observer judgement (e.g., the average percent of instream woody debris, or overall percentage of rock coverage along a line)

the ratings assigned and recorded were based on team collaboration, with at least two of the three team members agreeing on the recorded value. All point and line data were then entered into the computer by the electronics operator and onto a back-up field data recording form (Enclosure A1) by one of the biologists. A single 35-mm color photograph was also taken of the line, with the view recorded meant to be representative of the line's average conditions.

To conduct meaningful and valid interpretations and analyses of the GIS data, users should first have a thorough understanding of how the data were collected in the field and its potential limitations. Accordingly, the following clarifying notes are provided (for use in conjunction with the field form) to further explain procedures, methods, and potential limitations:

-Riprap Attributes-

- All observations of riprap and natural, earthen bank lines were made from the boat; disembarking the boat to clarify observations was not considered an option, due to the large number (475) of RMs to be surveyed.
- Rock riprap, classified as small (<12"), medium (12-20"), or large (>20"), refers to the average size of the rock (usually quarry rock) making up the majority of the surface coverage of the site. In other words, this is the dominant size of rock covering the site. The same definition was applied to the other riprap categories, including small (<20") and large (≥20") rubble; and small (<6"), medium (6-10"), and large (>10") cobble.
- When the bank or levee slope had more than one kind of dominant rock (e.g., for example, cobble along the shoreline with quarry rock higher up on the levee), the rock along the MSL was the one rated, except that height of revetment considered all the rock types present.
- Height of revetment, classified as <10', 11-20', 21-30', or >30', refers to the average vertical distance above MSL that rock or any other form of riprap extended up the bank or levee slope. Thus, the average surface area of riprap coverage up the bank or levee slope was often greater (due to the levee slope distance being greater than the vertical distance recorded) than the recorded values. Sometimes, along a given riprap line, the height of the riprap above MSL varied dramatically. When this occurred, a best-professional-judgement was made as to the average height above MSL. Height ND meant that the height could not be determined, usually due to sediment deposition atop the riprap, dense vegetative cover, or inability to see the bank or levee from the boat. It is likely that many of the ND lines had riprap well up the bank or levee, however.
- Sediment deposition atop the riprap (either YES>10%, or NO≤10%) was meant to indicate whether significant recent (last 2-3 years) sediment deposition had occurred along the line during high-flow conditions. Recent sedimentation atop riprap was usually characterized by silt or sand without significant vegetation coverage; less frequently, it

was characterized by predominantly annual herbaceous plant growth or first-year woody plant regeneration.

- Bank lines where the riprap was not in contact with the MSL of the channel (e.g., lines where rock only occurred along the upper bank or levee slope, with an earthen bank along the MSL) or where the riprap could not be seen from the boat, were recorded as natural, not riprapped, lines.
- Relative rock coverage along the line, recorded as either <25%, 25-60%, 61-90%, or >90%, refers to the percentage of the earthen substrate underlying the rocked area that was covered by the rock, rubble, or cobble riprap. Erosion of rock appeared to be the primary cause for the lower rock coverage values. And erosion appeared to be most common along the older rocked lines, especially the cobble lines. Some rock coverage values may have been mistakenly reduced, due to deep sediment covering the rock (which made it appear that the rock was missing).
- When the surface layer of riprap was a different type than a layer of riprap beneath it, the surface layer only was rated and evaluated.
- Trace of riprap was used to denote a short (25-100 feet) linear distance of any type of riprap (type not specified) along the bank. The average length of a trace riprap was about 75 feet. Trace riprap was also used to denote other bank protection features (and thus ecosystem-functioning impediments) placed along the shoreline, such as wooden cribwalls and metal sheet piles. When trace riprap was recorded along a rocked line, it denoted a change of riprap type (e.g., when a large rock riprap line had a pile of large concrete rubble placed around an irrigation pump intake). Trace riprap was most common at pump intakes and point-source outfalls, in or near scour holes, around fish screens and boat-launching ramps, and in front of private residential dwellings. The types of trace riprap were not recorded. However, all trace riprap occurrences should be assumed to be measures that halt stream ecosystem-functioning processes.

-Vegetation Attributes-

- Revegetation sites (i.e., sites actively replanted with riparian vegetation) of the Corps or other entities were only mapped (beginning and ending points along the bank lines) when they were clearly marked (with signage) and discernable from the boat. Many older revegetation sites were thus missed. No effort was made to rectify revegetation site placement using prior Corps revegetation contract information and specifications. However, this could and should be done later and added as another GIS layer.
- For both riprapped and natural bank lines, terrestrial vegetation characteristics were rated for the whole area of the line above the MSL that could be seen from the boat along the bank or levee slope and extending up to the uppermost elevation that could be seen. The

relative amount of vegetative ground cover in this area was rated as either <25%, 26-50%, 51-75%, or >75%. The estimate that was recorded refers to the total herbaceous and woody vegetation ground cover present on the date of the survey.

- To be rated as either woody or herbaceous vegetative type, the vegetation present along the bank line had to be >75% of that type, based on canopy cover of vegetation present on the date of survey. Lines that were less than 75% of either woody or herbaceous canopy cover were recorded as mixed vegetation lines.
- When the area being rated in association with a line was determined to be woody vegetation (i.e., >75% woody-growth canopy cover), it was then sub-classified as either mostly (>50% by canopy cover) scrub-shrub or mostly riparian forest. Scrub-shrub was assumed to average 20 feet or less in height, while riparian forest was assumed to average over 20 feet in height.
- When evaluating and rating vegetation where there was no distinct levee or bank slope (e.g., on large sand bars), the strip of vegetation within 100 feet of the MSL was rated.
- Many of the recorded canopy cover percentages, but especially for herbaceous cover, may significantly overestimate average annual vegetative values and conditions. The surveys were completed in mid-summer during the peak period of vegetative growth. Later in the fall, levee maintenance activities by reclamation districts, including burning, disking, and spraying with herbicides, likely significantly reduced vegetative ground cover along many of the surveyed reaches.
- Giant cane (*Arundo* spp.) was considered woody vegetation, either scrub-shrub or riparian forest, depending on the average height of the particular stand being considered. Himalayan blackberry and wild rose were both considered woody, scrub-shrub vegetation. Wild grape was considered herbaceous vegetation.
- In downstream-most reaches, emergent marsh began to appear along the channel margins. The percent of shoreline coverage by this (PEM=Palustrine Emergent Marsh) cover-type was rated just as SRA shaded overhang percent was rated (*see* below); on the field form, these PEM percentages were recorded as a footnote within the "average overhang grade" box. PEM frequently obscured the view of the bank or levee behind it. If the presence or absence of rock on such a bank or levee could not be visually verified, it was assumed to be a natural, earthen bank, since with the PEM present, it was generally functioning as one. Thus, where high amounts of PEM were present along shorelines, the presence and extent of riprap may have been underestimated. Since PEM refers to an aquatic, herbaceous type, it was not considered when rating the percent vegetative ground cover along the terrestrial (riparian) portion of the bank line.

-Instream Aquatic Attributes-

- Two water depths, each recorded as either <2.5 ft, 2.5-5.0 ft, >5-10 ft, or >10 ft, were taken at the end of each bank line. These were taken at 5 ft and 12 ft from, and perpendicular to, the shoreline of the MSL, using a marked PVC pole and 5- and 12-ft marks (from the bow of the boat) on the sides of the boat. Water depths were always taken from the side of the boat positioned on the just-completed bank line, with the bow resting on the MSL shoreline. While this was meant to ensure that the depths recorded were representative of depths along the just-completed bank line, this was not always the case, especially for relatively long or very diverse lines.
- Woody instream debris refers to woody material of any size which is in contact with the water (either wholly or partially submerged) at MSL and is firmly attached to the streambed or bank. Thus, driftwood which was not attached to the bank or stream bottom was not included. Such driftwood is likely to float away during the next high-flow event. However, attached woody pieces of all sizes, including living and dead tree and shrub branches which were protruding into the water, were included in the woody instream debris ratings.
- The rating given to woody instream debris along a bank line was either 0%, 1-10%, 11-50%, or >50%. The value recorded referred to the percent of the shoreline with instream wood at any distance up to 100 feet from the MSL shoreline (i.e., wood within a 100-ft-wide band). Any wooden pilings present in the water in association with docks, marinas, piers, and other structures, were considered instream wood and factored into the rating for a given bank line.
- SRA shaded shoreline overhang along each bank line was recorded as either 0%, 1-5%, 6-25%, 26-75%, or >75%. This refers to the estimated percent of the MSL shoreline with overhanging shade at noon during mid-summer. There was no consideration of the perpendicular distance from the shoreline that the shade extended. Thus, a bank line with an average of 3 ft of overhanging shade from woody, scrub-shrub vegetation along half of the bank line received the same rating as a line with 50 ft of overhanging shade from mature cottonwood trees along half the bank line; both occurrences would have been rated 26-75%.
- The grade (type) of the SRA shaded overhang of the line was rated as either low or high, however. Low meant that most of the overhang was within 10 vertical ft of the MSL surface; high denoted shade mostly >10 ft vertically above the MSL surface.
- Shade provided by docks, floating marinas, and other floating, man-made structures within 100 ft perpendicular to the MSL shoreline was factored into the shaded overhang ratings. Thus, the shade from such structures was considered the same as the shade provided by riparian vegetation.

-Other Associated Attributes-

- Vertical banks were recorded (as points along the bank lines) only if they extended at least 10 ft vertically and horizontally (linearly along the shoreline) and were within 50 ft of the MSL shoreline. However, a few vertical banks not meeting these minimal criteria were also recorded if there was visual evidence of bank-swallow usage (or other burrowing-animal usage) in the vertical (or near-vertical) bank face. Bank swallow usage was determined by the presence of the birds themselves, or from their typical burrow and dropping patterns along the vertical bank face.
- When a vertical bank continued for more than 75 linear ft along a line, one point was recorded roughly every 75 ft. Thus, where multiple vertical bank points are recorded, average length of the vertical bank was about 75 ft. The average length of all the other, individual vertical bank points may have been somewhat less, probably an average of about 50 ft.
- Scour holes (areas of active erosion) were recorded if they extended at least 10 ft horizontally along the bank and showed evidence (loose, eroding substrates and/or significantly less vegetation than along the remainder of that bank line) of recent scouring. Scour holes were recorded as points indicating a depth into the bank of either 1-10ft, 11-25 ft, or >25 ft. Special note was made of scour holes occurring at the ends of bank lines. There was difficulty in seeing all scour holes from a moving (sometimes at relatively high speed) boat. In addition, scour hole detection was often reduced by dense riparian vegetation and/or instream wood. Thus, the GIS data for this element should be assumed to represent only general conditions and trends along each surveyed reach, and not the absolute, precise location and size of every significant erosion spot of potential interest to flood control management efforts.
- Natural bank lines were rated as being either mostly erosional, mostly stable, or mostly depositional. Mostly erosional meant there were active scour holes or significant mass bank wasting sites clearly visible. Mostly depositional generally meant there were large sand bars, usually without any significant vegetation.
- The beginning and ending point of each marina was recorded along the bank lines. A marina was considered to be any commercially-oriented boat dockage operation. Public boat docks (free or commercial) operated by municipalities were also included in this category.
- Each private boat dock up to 100 feet from the MSL shoreline, regardless of its size, was recorded as a point along the bank line. Most private boat docks were associated with private residential dwellings along the bank or just outside the levee. However, to be recorded, the dock had to show evidence of current usage in the form of a walk-way connected to the bank and a dock surface which appeared usable.

- Wing dams and groins constructed of rock (most commonly) or other materials (e.g., using wooden cribwalls) were recorded as points along the bank lines. However, only those wing dams and groins which could be readily observed and identified from the boat on the date of survey were recorded.
- All public and private (no differentiation) boat-launching ramps were recorded at points along the bank lines.
- A 35 mm color, still photograph was taken along every bank line, usually at the end of the line looking back onto it. However, along very long bank lines, photos were often taken nearer the center of the line. In any case, an effort was made to ensure that each photograph was representative of the conditions present along the line.
- When MSL conditions were not prevalent on the date of a survey, an appropriate visual adjustment was made to the water level (i.e., visually adding to or subtracting from the existing water surface elevation) before the bank-line attributes were estimated. The basis for these adjustments are provided in Enclosure C.

-ENCLOSURE A1-

Field Data Recording Form Used During July-October 2002 Surveys

2002 Riprap GIS Survey of Sacramento River and distributaries, downstream of Colusa.

Date: _____ RM: _____ Bank Side: <u>R/L</u> Direction: <u>UP/DS</u>	
GPS: N <u>38</u> W <u>121</u>	
Bank Type	Bank Characteristics
<i>Rock Riprap</i>	<i>Height of Revetment</i>
small <12" _____ medium 12-20" _____ large >20" _____	<10' _____ 11-20' _____ 21-30' _____ >30' _____ ND _____ Comment _____
<i>Other Riprap</i>	<i>Vegetation Characteristics</i>
small <20" rubble _____ large >20" rubble _____ small <6" cobble _____ medium 6-10" cobble _____ large >10" cobble _____ other _____	>75% of veg is woody _____ >75% of veg is herbac _____ mixed (<75% either one) _____ Natural _____ Replanted _____
	<i>Average Overhang Grade</i>
	low <10' _____ high >10' _____
	<i>Palustrine Emergent Marsh (PEM)</i>
	None _____ 1-5% _____ 6-25% _____ 26-75% _____ >75% _____
<i>Sediment Deposition (Rock)</i>	<i>If Mostly Woody, then...</i>
Yes >10% coverage _____ No <10% coverage _____	Mostly scrub-shrub <20' _____ Mostly riparian for >20' _____
<i>Relative Rock Coverage</i>	<i>Vegetation Ground Cover</i>
<25% _____ 25-60% _____ 60-90% _____ >90% _____ comments _____	<25% _____ 26-50% _____ 51-75% _____ >75% _____ (Of all the vegetation present)
<i>Natural Bank (not rock)</i>	<i>Is a Scour Hole Present at End of the Line?</i>
Mostly Erosional _____ Mostly Depositional _____ Mostly Stable _____	_____ No _____ Yes
<i>Scour Holes >10lf present along the line?</i>	<i>Max. Depth of Scour Hole at End of the Line?</i>
No _____ Yes 1-3 _____ Yes 4-10 _____ Yes >10 _____	N/A _____ 1-10' _____ 11-25' _____ >25' _____
<i>Max. Scour Hole Depth along the line.</i>	<i>Marina Present</i>
N/A _____ 1-10' _____ 11-25' _____ >25' _____	No _____ Yes _____
	<i>Groins Present</i>
	_____ No _____ Yes
	<i>Wing Dams Present</i>
	_____ No _____ Yes